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OHIO DEPARTMENT OF HEALTH, DIVISION  
OF ADULT HYGIENE

CHLORINE



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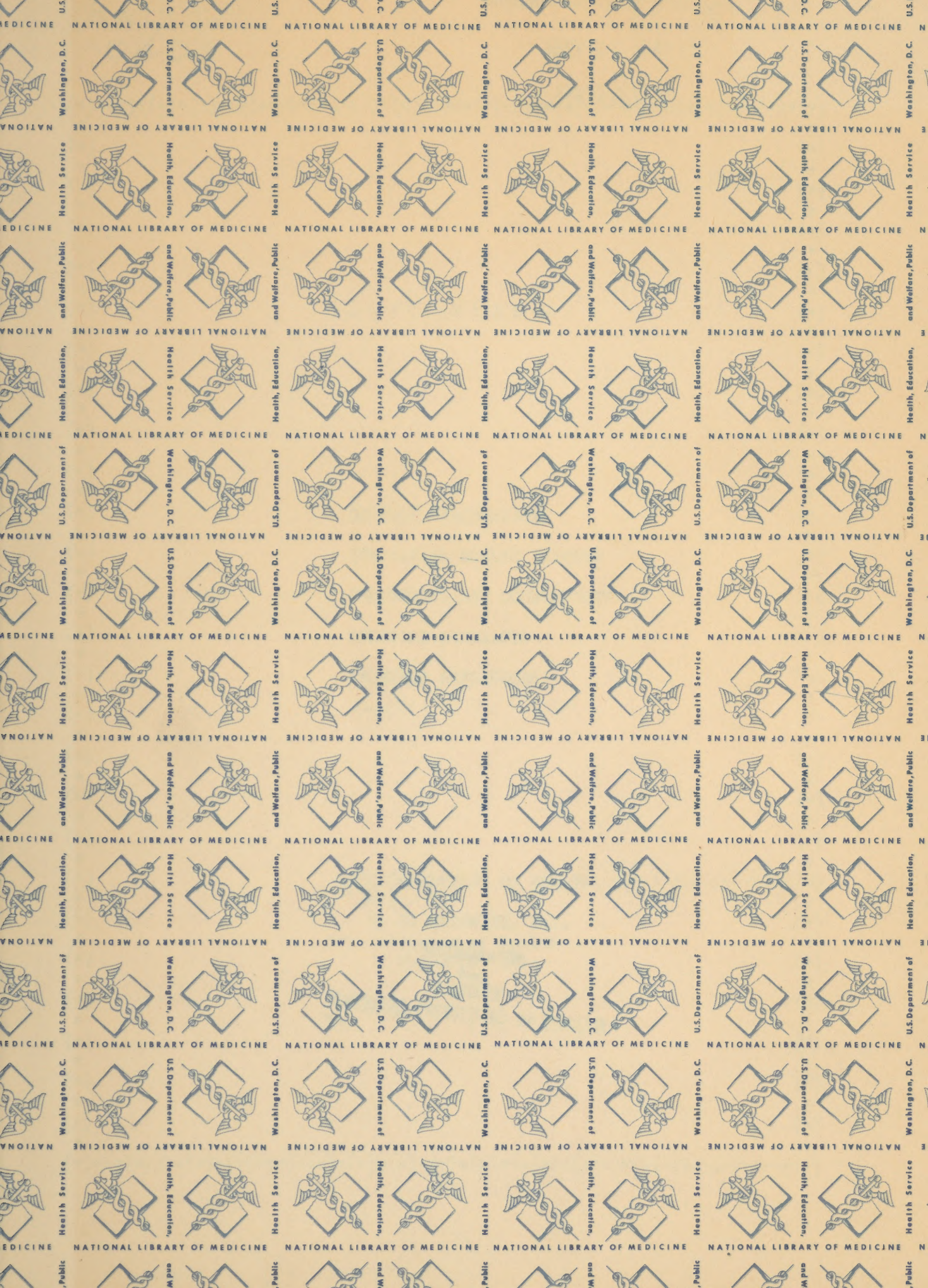
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-- CHLORINE --

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OHIO DEPARTMENT OF HEALTH. *Division of Health*

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## -- CHLORINE --

Chlorine ranks 12th in abundance among all the elements. Its irritating and suffocating properties have been known since its discovery by Scheele in 1774. Davy proved it to be an element in 1810. Berthollet was responsible for introducing chlorine to industry as a bleaching agent. As an illustration of its abundance in nature, if all of the chlorine in the sea water were crystallized out as salt, it would be sufficient to form a crust 100 feet thick over the entire surface of the earth. Chlorine constitutes approximately 2% of the sea water.

Chloracne was first observed and described by Herxheimer in 1899 among workers manufacturing chlorine electrolytically. On April 22, 1915, the use of chlorine marked the beginning of chemical warfare in the world war.

Large quantities of chlorine are being made today by the electrolysis of aqueous solutions of alkaline chlorides or of fused chlorides. Modern installations have reduced the danger of chlorine escaping during the manufacture.

### GENERAL INFORMATION

CHEMICAL FORMULA AND SYNONYMS:  $\text{Cl}_2$ , liquid bleach.

PROPERTIES: Heavy, greenish-yellow gas or liquid; poisonous! Sp. gr., 2.491; m. p.  $-102^\circ\text{C}$ .; b. p.  $-33.6^\circ\text{C}$ . Soluble in water and alkalis. Weight per liter, 2.95 gr.

PREPARATION: By the electrolysis of sodium chloride in solution. The chlorine is released at the positive electrode. The chlorine is either liquidified by compression in steel cylinders or employed at once for making bleach or bleaching powder, or for chlorinating organic substances.

IMPORTANT COMPOUNDS: Sodium chloride, calcium chloride, hydrochloric acid, perchloric acid and many other inorganic compounds of chlorine; chloroform, carbon tetrachloride, chlorobenzene, chlorophenols and many other organic compounds of chlorine.

USES: Organic synthesis; chlorination; hydrochloric acid; textile bleaching liquor; water purification; military poison gas; metallurgy (recovery of gold and silver from their ores, extraction of copper, lead and zinc from mixed ores, separation of tungsten and vanadium from their ores, detinning scrap white cast iron and dezincing scrap galvanized iron obtaining, as by-products, tin and zinc chlorides, respectively, free of iron, when using gaseous chlorine, absolutely free of water); inks, paper (bleaching); rubber substitutes; chlorinated rubber, water purification.







## INDUSTRIAL HEALTH ASPECTS

MODES OF ENTRANCE: Inhalation.

SYMPTOMS OF INDUSTRIAL POISONING: The symptoms of poisoning by chlorine gas are primarily concerned with irritation of the respiratory system. Fifteen parts per million causes immediate irritation of the throat and with higher concentration irritation of the conjunctiva. Fifty parts per million produces strong dyspnea, cyanosis and death. The symptoms will vary with the concentration and time during which the gas is inhaled. Sustained exposures may cause bronchitis, bronchiectasis, loss of sense of smell, loss of appetite with loss of weight, headache, giddiness, insomnia and cardiac disturbances.

The following table indicates the exposure to various concentrations of chlorine:

Physiological Response to Various Concentrations of Chlorine.

	Parts of Chlorine per Million Parts of Air
Least detectable odor* . . . . .	3.5
Least amount causing immediate irritation to the throat* .	15.1
Least amount causing coughing* . . . . .	30.2
Maximum concentration allowable for prolonged exposure* . .	1.0
Maximum concentration allowable for short exposure ( $\frac{1}{2}$ to 1 hour)** . . . . .	4.0
Dangerous for even short exposure** . . . . .	40 to 60
Rapidly fatal for short exposure** . . . . .	1,000

\*U.S. Department of the Interior, Bureau of Mines, Technical Paper 248, 1921.

\*\*Kobert, R., Kompendium der prak. Toxikol, Stuttgart, 1912.





## INDUSTRIES AND OCCUPATIONS

INDUSTRIES: Ohio Industries using chlorine as indicated in the Ohio Industrial Hygiene Survey are listed as follows:

Blackings, cleaners, etc.	Laundries
Chemicals	Other manufacturing plants
Cotton cloth	Other textiles
Dairy products	Paper and pulp mills
Dry cleaning and dyeing	Soft beverages
Dyestuffs, ink	Textile dyeing and finishing.
Electrical machinery	

OCCUPATIONS: Occupations in Ohio where contact with chlorine was indicated are listed as follows:

Attendants (chemicals)	laundries; electrical machinery; dyestuffs, inks)
Bleachers (cotton cloth; textile dyeing and finishing)	Machine operators (other textiles; paper pulp mills; chemicals)
Bottle washers (dairy products)	Mixers (blackings, cleaners, etc.)
Bottlers (blackings, cleaners, etc.)	Platers (other manufacturing plants)
Brine tenders (chemicals)	Porters (soft beverages)
Chemists (dyestuffs, ink; paper and pulp mills)	Pullers (laundries)
Cleaners (dairy products)	Punch press operators (blackings, cleaners, etc.)
Chlorine house operators (paper and pulp mills)	Spotters (dry cleaning and dyeing)
Dumpers (blackings, cleaners, etc.)	Sorting clerks (laundries)
Extractors (laundries)	Washing machine operators (dry cleaning and dyeing; laundries; soft beverages)
Foremen (laundries; soft beverages)	Wringers (laundries)
Hand starchers (laundries)	
Hand washers (laundries)	
Laundrymen (dry cleaning and dyeing;	

Occupations which offer contact with chlorine but not listed in the Ohio Survey are:\*

Alkali-salt makers	Ink makers
Beatermen (paper and pulp)	Iodine makers
Bromine makers	Phosgene makers
Broom makers	Photographic workers
Calico printers	Rubber-substitute makers
Chloride of lime makers	Shoddy makers
Color makers	Soda makers
Detinning workers	Tear-gas makers
Disinfectant makers	

\*Dublin, L.I., and Vane, R.J., Occupation Hazards and Diagnostic Signs, U.S. Department of Labor, Bureau of Labor Statistics, Bulletin No. 582: 34, 1933.





## SELECTED ABSTRACTS

### LUNG IRRITATION FROM CHLORINE.

O. Schulz. Aertzl. Sachverstand.-Ztg., vol. 43, pp. 14-15 (1937).

Abstracted in J. of Ind. Hygiene, vol. 19, no. 4, pp. 82-83 (abstract section) April 1937.

A physician undertook to try out a new disinfectant for one-half hour in a room. The material which contained lye, boric acid, glycerine and chlorine was very finely ground. He had a definite feeling of sickness; on the 3rd day there was inflammation of the lung. The author thus affirms the connection between chlorine inhalation and lung irritation.--L. Teleky.

### MITRAL STENOSIS AFTER REPEATED CHLORINE GAS POISONING.

H. Pernice. Deutsch. Med. Wchnschr., Oct. 27, 1933, vol. 59, pp. 1644-1646.

Abstracted in J. of Ind. Hygiene, vol. 16, no. 2, p. 27 (abstract section) March 1934.

A 34-year old metal worker was in perfect health before he began to work in the chlorine bleaching department of a cellulose factory, where he did repairs on pipes and kettles, in the course of which he suffered several severe attacks of chlorine poisoning between 1923 and 1927. In 1932 mitral stenosis was discovered, together with a severe secondary anemia, but there was no tuberculosis. Since no history of the diseases that give rise to mitral stenosis could be found, and since medical examination at the beginning of his employment in the chlorine department had shown heart and vascular system to be normal, the valvular lesion was attributed to the effect of the chlorine. In support of this theory the author quotes David, who found severe injury to the coronary arteries in a victim of chlorine gas poisoning in a cellulose factory, and also Lewin, who says that chlorine increases the viscosity of the blood, and Petri, who suggests that the latter leads to thrombosis with formation of infarcts, which could cause hardening of the valves and stenosis.--Alice Hamilton.

### INDUSTRIAL POISONING FROM LOW CONCENTRATIONS OF CHLORINE GAS.

C.P. McCord. Jour. Am. Med. Assn., May 29, 1926, vol. 86, pp. 1687-1688.

Abstracted in J. of Ind. Hygiene, vol. 8, no. 10, p. 183 (abstract section) Oct. 1926.

McCord describes a case of emphysema which he attributes to prolonged exposure to low concentrations of chlorine gas arising from work processes.--K.R.D.

### CHLORINE GAS POISONING.

G. Lutz. Abstr. as follows from Zentralbl. f. Gewerbehyg., May, 1927, N.S. vol. 4, pp. 175-176, in Bull. Hyg., Nov., 1927, vol. 2, p. 881.

Abstracted in J. of Ind. Hygiene, vol. 10, no. 3, pp. 62-63 (abstract section) March 1928.

Lutz describes disappearance in himself, after rather severe gassing





from chlorine, not only of the unpleasant smell but also of chest symptoms, lacrimation, salivation, loss of energy, etc., after taking strong coffee. He therefore advocates caffein as a remedy of great value in chlorine gassing. Even after absence on holiday for some weeks he remained immune from recurrence of the symptoms.

#### INDUSTRIAL CHLORINE GAS POISONING.

E. Schulze. Samm. v. Vergiftsf., (Vergiftungsfalle) vol. 10, pp. 1-2 (Jan. 1939).

Abstracted in J. of Ind. Hygiene, vol. 21, no. 6, p. 139 (abstract section) June 1939.

A worker in a small chemical plant was exposed to chlorine gas during the course of an experiment. Although he had breathed only a small amount of the gas, he had to be helped from the room and then lost consciousness. At the hospital he developed an acute, severe bronchitis. About 5 wks. later this seemed to have been cured but it developed again a few weeks later. The bronchitis became chronic and the patient was troubled with an increasingly severe cough and dyspnea. In summer the condition was stationary. Respiratory functions were badly disturbed; vital capacity was only 1000 cc. and respiratory minute volume was almost double the normal. The case is unusual in that non-fatal cases usually do not lead to this chronic condition.--Helen Lawson.

#### CHLORACNE.

Nicolas and Pillon. Paris med., Jan. 16, 1926, pp. 62-68.

Abstracted in J. of Ind. Hygiene, vol. 8, no. 10, p. 186 (abstract section) Oct. 1926.

In this review of the subject, the writers have added another case to the one they reported last year. This man was working in the manufacture of chlorine from chloride of sodium by the electrolytic process. It was noted that others were affected who were laboring, as he was, on the repairing of the electrodes. These are made of charcoal mixed with pitch. From a careful analysis of the products given off at the anodes, a chemist, Mr. Sisley, has isolated chlorinated naphthalene which he considers is the peccant agent. The first case reported by Messrs. Nicolas and Pillon occurred in a zinc galvanizing plant, and they are unable to point out the exact cause.

The lesions in both instances were characteristic of the condition.  
--R.P.W.

#### DANGERS IN THE ELECTROLYTIC PRODUCTION OF CHLORINE BY THE AMALGAM PROCESS.

I. Brachmann. Arbeitsschutz, pp. 255-257 (1938).

Abstracted in J. of Ind. Hygiene, vol. 21, no. 3, p. 71 (abstract section) March 1939.

The electrolytic method of producing chlorine is based on the decomposition of NaCl by means of electrical current. Hg is used for the cathode, it combines with Na, and Cl is liberated. The author has investigated two factories, in one of which every precaution against poisoning was taken. There were no signs of mercury poisoning or chlor acne. In the other factory





nearly all the workers showed signs of mercury poisoning as well as the skin trouble.--L. Teleky.

METHODS FOR THE DETECTION OF TOXIC GASES IN INDUSTRY: CHLORINE. LEAFLET NO. 10.

Dept. Sci. & Industr. Research, H.M. Stationery Office, London, 1939.

Abstracted in J. of Ind. Hygiene, vol. 22, no. 1, p. 20 (abstract section) Jan. 1940.

Risks of exposure to chlorine occur chiefly during its manufacture and use in industry, and generally as the results of accidents in which large quantities of the gas escape from cylinders or other containers. Dangerous concentrations may be met in alkali (electrolytic) works, bleaching works, chemical works, dye-making and dye-using works, tanneries, tin-plate works, water purification works, amongst others.

Acute poisoning by chlorine is unusual, as by its strong smell and irritant qualities it is easily detected. It can be recognized by smell in concentrations as low as 1 p.p.m. There may be some degree of habituation to the gas, but ill-effects of repeated exposures have been described, such as chronic bronchitis, eye affections, chronic gastritis and sleeplessness. The effects of various concentrations (parts by volume) are: 1 in 1,000, a brief exposure is rapidly fatal by asphyxia; 1 in 10,000, exposure of a few seconds is intolerable; 1 in 20,000, exposure for 30 minutes is very dangerous owing to acute pulmonary edema; 1 in 100,000, 60 minutes' exposure causes bronchitis; 1 in 1 million, prolonged exposure is permissible.

This leaflet describes a simple method of detecting and estimating chlorine in air in concentrations as low as 1 in 1 million. Samples of the air under test are drawn, by a hand pump of definite capacity, through a bubbler of o-tolidine solution until the depth of color produced is equal to that of one of a series of standards prepared from potassium dichromate solution. From the number of strokes required the concentration is then obtained by reference to a table.

The pump and bubbler are described, and instructions for the preparation of the reagent and the standard colors, and for the carrying out of the test, are given in the leaflet.--T. Bedford.

MEMORANDUM ON PRECAUTIONS IN THE HANDLING, STORAGE AND USE OF LIQUID CHLORINE.

Factory Department, Home Office, Form 1868, H.M. Stationery Office, London (April 1937).

Abstracted in J. of Ind. Hygiene, vol. 20, no. 1, p. 28 (abstract section) Jan. 1938.

No liquid chlorine should be discharged from any container unless the person in charge of the operation has the requisite knowledge and experience. Cylinders and drums containing liquid chlorine should be properly stored (under cover, not in the main building, protected from heat and damp, away from danger of fire or explosion, and in a place from which they can readily be removed in case of fire). In opening a chlorine cylinder the supplier's directions should be strictly followed. Containers





should be so secured that all risk of unexpected movement during dischargeing is avoided. Heat should on no account be applied to the containers to assist liberation of the gas. Precautions should be taken to avoid damage to valves, pipes and couplings. Illustrations are given of suitable slings for lifting cylinders and drums, and such slings should be tested to twice the required tension. Wrought iron slings should be annealed and examined periodically. It is essential that compressed air for use with liquid chlorine in tank wagons and storage tanks should be perfectly dry and free from lubricating oil, otherwise corrosion of the tank will occur. If the use of containers in a confined space is unavoidable efficient exhaust fans working at low level should be provided. Leakages can be traced by means of ammonia fumes. When a container leaks the point of leakage should be turned upwards to prevent leakage of liquid. The precautions to be taken in the event of a substantial escape of gas occurring are outlined. Canister respirators should be provided and stored in convenient places, and where large quantities of liquid chlorine are stored there should be a selfcontained oxygen breathing apparatus, half-hour type, at each end of the plant, and workmen should be trained in its use.

Instructions for first-aid treatment of gassed patients by ambulance men are given. Notes are given for the guidance of medical officers without previous experience of chlorine gassed patients. These are:

- (1) Give three-hourly doses of stimulating expectorant mixture containing Ammonium Carbonate gr. x-xv, Vin. Ipecacuanhae m. xv.
- (2) Apply hot poultices to patient's chest.
- (3) Venesection to the extent of 10-12 oz. of blood should be performed where cyanosis and dyspnea are marked.
- (4) Tinct. Opii m. v-xv may be advisable to allay the mental strain of a restless patient.
- (5) In a case of the heart threatening to fail, pituitary extract (1 cc.) coramine (1 to 2 cc.) and brandy should be given and repeated as necessary.--T. Bedford.





## SELECTED REFERENCES

Barbour, H.G., Hjort, A.M., and Taylor, F.A.: Drugs after Chlorine Gassing. I. The Influence of Morphine Upon the Fatality of Chlorine Poisoning. Jour. Pharmacol. and Exper. Therap., vol. 14, no. 1, pp. 55-59, Sept. 1919.

Barbour, H.G.: Drugs after Chlorine Gassing. II. Observations upon the Treatment of Gassed Dogs with Circulatory Stimulants. Jour. Pharmacol. and Exper. Therap., vol. 14, no. 1, pp. 61-64, Sept. 1919.

Barbour, H.G., and Williams, H.W.: The Effects of Chlorine Upon Isolated Bronchi and Pulmonary Vessels. Jour. Pharmacol. and Exper. Therap., vol. 14, no. 1, pp. 47-53, Sept. 1919.

Etienne-Martin, P.: Poisoning by Chlorine. Med. du travail, vol. 4, pp. 83-96, and 138-152, 1932.

Freund, R.: Working with Compressed Chlorine Gas in Practice. Chem-Ztg., vol. 52, pp. 33-34, 1928.

Hamilton, A.: Indust. Toxicology. Harper and Brothers, New York, 1934, pp. 6-8.

Henderson, Y., and Haggard, H.: Noxious Gases. The Chemical Catalog Co., Inc., Publishers, New York, 1927, pp. 131-132.

Kober, G., and Hayhurst, E.: Industrial Health. P. Blakiston's Son and Co., 1924, pp. 573-574.

McNally, W.: Toxicology. Industrial Medicine, Publishers, Chicago, 1937, pp. 111-115.

Memorandum on Precautions in the Handling, Storage and Use of Liquid Chlorine. Factory Department, Home Office, Form 1868, H.M. Stationery Office, London, April 1937.

Nicolas, J., and Lacassagne, J.: A Case of Chlorine Acne. Bull. Soc. franc. de dermat. et syph., p. 223, March 1929.

Nielsen, J. Behn: Behavior of Gas-Mask Charcoal Towards Phosgene and Chlorine. Z. ges. Schiess-Sprengstoffw., vol. 27, pp. 280-284, 1932.

Occupation and Health. International Labour Office, Geneva, 1934, pp. 429-436.

Reyerson, L.H., and Wishart, A.W.: The Sorption of Chlorine by Activated Charcoal. Jour. Phys. Chem. vol. 42, pp. 679-685, 1938.

Rochaix, A.: The Dangers Associated with Using Certain Plant for Chlorine Solvents in Cleaning Clothes. Ann. d'hyg. pub., vol. 14, pp. 61-64, 1936.





Safe Handling of Chlorine: Safe Practices Pamphlet No. 71, Nat. Safety News., vol. 13, pp. 39-43, March 1926.

Shera, Vrian L.: Safe and Proper Handling of Liquid Chlorine. Pacific Chem. Med. Inds. vol. 2, no. 5, pp. 19-22, 1938.

Sklanskaja, R.M., Klaus, L.M., Sidorovau, L.M., and Rapoport, J.L.: Influence of Chlorine on the Female Organism. Gigiena truda i tehnika bezopasnosti, no. 1, pp. 12-25, 1935.

Tupholme, C.H.S.: Safety Hints for Liquid Chlorine. Chem. Industries, vol. 43, p. 20, 1938.

Walton, D.C., and Eldridge, W.A.: The Action of Chlorine on Men Poisoned by Toxic Smokes. Jour. Pharmacol. and Exper. Therap., vol. 35, pp. 241-256, 1929. .

Warson, T.E.: Note on the Determination of Chlorine. Jour. Am. Water Works Assoc., vol. 29, pp. 1775-1776, 1937.

Yoe, J.H.: A Convenient Apparatus for the Determination of Low Concentrations of Chlorine in Chlorine-Air Mixtures. Jour. Lab. and Clin. Med., vol. 10, pp. 1041-1045, 1925.























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